[0012] FIG. **3** shows a graphical representation of the fluorescence spectrum of polymer P2 upon titration with Acid Red (AR) 112.

[0013] FIG. **4** shows a structural representation of the 12 target dye analytes detected using polymers P1-P3 using the inner filter effect, linear discriminant analysis, and principal component analysis.

[0014] FIG. **5** shows the two-dimensional scores and loadings plots from linear discriminant analysis which graphically represents the data processing for the detection of the 12 target dye analytes with polymers P1-P3.

[0015] FIG. **6** shows the two-dimensional scores and loadings plots from principal component analysis which graphically represents the data processing for the detection of the 12 target dye analytes with polymers P1-P3.

[0016] FIG. **7** shows the identity and structure of conjugated polymer P4 and a representative example of a solid-state polymer sensor.

[0017] FIG. **8** shows a pictorial representation demonstrating the operation of a solid-state sensor using the inner filter effect to detect a spatially separated analyte.

[0018] FIG. **9** shows a graphical representation of the fluorescence spectrum of polymer P4 in the solid-state upon titration with Congo Red (CR).

DESCRIPTION OF EMBODIMENT(S)

[0019] The present invention provides new methods and processes for the preparation and utilization of conjugated polymer (CP) based sensors which operate via the inner filter effect (IFE) and multivariate pattern recognition. Further, the invention provides methods of utilizing CPs with controlled optical properties for targeted sensing applications. The invention proceeds through a novel IFE array-sensing method, providing sensitive and selective sensors that can be used in various environments. The invention further provides calibration standards for the identification of similar and structurally distinct target analytes, where an analyte is a small molecule, macromolecule, or biological organism of interest.

[0020] Specifically, the invention provides methods of detecting one or more analyte(s) using at least one π-conjugated polymer (CP) as a sensor, whereby and wherein the fluorescence of the at least one π-conjugated polymer (CP) is altered by the analyte(s). Fluorescence is the emission of electromagnetic radiation; here, the polymer emits electromagnetic radiation which can be monitored as the signal for detection. Detection is defined as identifying the presence of a substance or sample, also known as an analyte, as well as identifying what specific analyte the substance is, i.e., the presence and the identification of the analyte. The detection of the analyte(s), or the discrimination of different analytes, is defined as the data or knowledge that analyte(s) exists or is present and the data, knowledge, or identification of what type of analyte(s) are present.

[0021] In one embodiment, a conjugated polymer and an analyte are mixed in a liquid solution, i.e., the same solution. Electromagnetic radiation, i.e., energy, is applied to the solution and therefore also to the polymer. The liquid solution can be static (not moving or flowing) or dynamic (moving or flowing). Light is shined through the solution and radiation is detected. The analyte(s) change or attenuate the radiation or fluorescence of the polymer (quenching) by absorbing the electromagnetic radiation used to excite the polymer, or by absorbing the emitted electromagnetic radiation from the polymer, which is known as the Inner Filter Effect (IFE). As the IFE operates through space and does not require a physical interaction, the polymer and the analyte(s) can be mixed together in a solution or separated in this method. Depending on the structure and optical properties of the polymer and the analyte, there are differences in fluorescence quenching. One or more analytes can be detected by using multiple polymers that are quenched differently by each analyte. The method enables the measurement of the attenuated fluorescence from the polymer, followed by processing and/or analysis, by at least one algorithm or means of processing, from a plurality of algorithms or means of processing, via a computer-based or micro-processor-based device and/or a non-transitory computer-readable medium, the attenuated fluorescence data to detect the presence and/or the type of the analyte. The algorithm or means of processing may comprise at least one machine learning algorithm.

[0022] In other embodiments, the polymer and the analyte may be placed in different solutions such that the polymer is not mixed with the analyte in the same solution and the polymer and analyte do not touch each other. The polymer is or can be placed in a first solution and the analyte placed in a separate, second solution, wherein the first solution consists of or is made of a different solvent than the second solution, such that the polymer and the analyte are in their own respective, individual solutions. Alternatively, the two individual first and second solutions may consist of or are made of the same solvent. Further, the first solution may be static and the second solution may be dynamic, or vice versa, or, alternatively, both solutions may be static or both solutions may be dynamic. Light can be passed through both solutions to provide fluorescence quenching for detecting and/or the discrimination of analyte(s).

[0023] The concentration of the analyte that can be detected from this method is referred to as the sensitivity. The lower the concentration of an analyte that can be detected, the greater the sensitivity of the sensor provided by the method. The concentration of the analyte that may be detected using this method ranges from femtomolar concentrations, to nanomolar, micromolar, millimolar, and to molar concentrations and above.

[0024] The collected fluorescence data is or can be processed through common and widely accessible multivariate pattern recognition algorithms, such as Linear Discriminant Analysis (LDA) and Principal Component Analysis (PCA), for example. These algorithms process the collected data and reduce the size and complexity, allowing for the discrimination of multiple analytes. The output of the algorithm is or can be a two-dimensional scores plot, which visualizes the discrimination of each analyte and acts as a calibration plot of the sensor, and a two-dimensional loadings plot, which describes how the algorithm generated the scores plot. Visualization is and provides a generated graphical plot for viewing or visualizing the analyte data and the discrimination or detection of each analyte. The discrimination of multiple analytes is or can be visualized by an algorithm, from a plurality of algorithms, that comprises at least one machine learning algorithm. An algorithm is not necessary in the case wherein only one analyte is to be detected.

[0025] The methods provide several advantages compared to traditional CP-based sensing approaches: 1) the new methodology overcomes the use of receptor chemistries and host-guest interactions typically utilized in CP-based sen-